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MONEY AND PRICES IN THE EARLY ROMAN EMPIRE

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Money and Prices in the Early Roman Empire

David Kessler and Peter Temin*

Abstract

We examine monetization in the early Roman Empire by considering money as a unit of account. Widespread use of prices indicates widespread monetization. A consistent set of prices for wheat indicates that this monetization encouraged trade to grow across the Mediterranean. This argument is documented with a statistical test, preceded by a non-technical introduction and followed by consideration of a range of possible objections.

Keywords: money, monetization, international trade, regression analysis, Roman Empire

JEL Codes: N13, F14, C10

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Money and Prices in the Early Roman Empire

Money serves as a medium of exchange and a standard unit in which prices and debts can be expressed.[1] Most research on the extent of monetization in the Roman world has focused on the first function of money, a medium of exchange. Hopkins' famous article on taxes and trade argued that money would be needed throughout the empire to pay taxes; Duncan-Jones inferred geographically limited coin usage from the location of coin hoards.[2] This paper examines the second function of money, its role as a standard of value. We argue that monetization in the sense of using monetary measures was virtually universal in the early Roman Empire. This assertion verges on the obvious in view of recent compilations of Roman prices.[3] We go further to make the stronger and less obvious claim that there was unified monetary integration across the whole Mediterranean in the early Roman Empire. We make this argument through an examination of wheat prices.

We approach the issue of monetization from a new angle, emphasizing the role of money in supplying a unit of account. This leads us to look for Roman uses of this unit. In other words, we look for Roman prices instead of Roman coins. Monetization in this view is measured by the extent to which people used prices to keep track of their activities. This may appear less direct than analyzing coins, but it is not. We are interested in monetization as an aspect of Roman society, and we focus on how the Romans used money instead of asking how much money they had. The use of prices is our index of monetization.

We assume that money was used as money in the ancient world. Some historians have seen coins as symbols of imperial power or as art objects. These characteristics may be important for the question of which coins were used, but they do not approach the question why the ancients minted coins in the first place. Perhaps Roman emperors spread Roman coins widely to symbolize their suzerainty, but with coins came the practice of using money to value commodities and services. Actually, this practice preceded coins in the East and became more accurate and prevalent with coins. Uniform *sestertii*—linked to earlier *drachmae* in the East—encouraged the use of prices in transactions. Consistent valuations and ease of payment (the first function of money) encouraged the growth of trade.[4]

Prices were used widely in Rome, and the letters and accounts of the time are full of references to them. Unhappily for the modern scholar, the prices almost always are for goods or services that are unique, ranging from dinner parties to monuments. The accounts reveal that people thought in terms of prices, but they do not provide a data set with which to examine prices. Prices for a uniform commodity are needed for that purpose. Wheat is the obvious candidate for such a price because wheat was both uniform and universal. Rathbone used the price of wheat in Roman Egypt to measure inflation.[5] We compare wheat prices across space rather than through time to demonstrate market integration around the Mediterranean. Market integration indicates widespread monetization, which facilitated trade by providing a standard unit of account. Just as the euro promotes European trade today, the wide use of *sestertii* and *drachmae* encouraged trade throughout the Roman Mediterranean.

Despite the availability of Roman price evidence, it is difficult to find comparable prices for many locations. We take our sample to be a set of wheat prices listed by Rickman in his account of its supply for the city of Rome.[6] This is a small sample of prices, but we think it is a good one for three reasons. First, Rickman searched the literature for mentions of wheat prices in outlying areas. Second, he compared prices in these outlying areas with prices in Rome, and we use this roughly contemporaneous comparison in our work. Third, we are not aware of another attempt to provide a set of prices for a uniform commodity in many different parts of the late Roman Republic and early Roman Empire.

We proceed in three steps. We first explain this small data set and its strengths and weaknesses, construct a graph showing the relation of wheat prices in Rome to those elsewhere around the Mediterranean, and present our hypothesis in the form of a graph. Then we ask if this graph could be a fluke, that is, a chance result of putting together prices that in fact were not the result of an integrated market. If not, then the collection of prices from distant places would reveal nascent monetization (since prices were used) but not comprehensive monetization (that would encourage trade). There would be no relationship between the various prices. This test requires a short introduction to statistics that tries to be informative without being too technical. Finally, we discuss a variety of objections to this finding that might be raised, showing that they do not vitiate our results.

Data and Hypothesis

We collected wheat prices from varied locations, as reported by Rickman. More prices come to light all the time, but we thought that this familiar sample would provide a way to examine monetary integration at least provisionally. Our requirements were price pairs in outlying locations and in Rome at roughly the same time. We found six price pairs in almost two centuries ranging from the late Republic to the early Empire. This is not an overwhelming amount of evidence, but it is enough to test whether the patterns in the data are random or not. In each case the Roman price was subtracted from the price at the distant location to give a price differential. Wheat prices at Rome were subject to slow inflation according to Rickman, a view that has been supported by Duncan-Jones.[7]

We describe the price observations in the order of their distance from Rome, which we calculated as straight-line distances on a map. This of course is only an approximation to the actual distance that wheat traveled; we emphasize the approximate nature of our data since this randomness reduces the possibility of finding evidence of comprehensive monetization. The closest price was from Sicily and came from Cicero's Verrine Orations. One of his accusations was that Verres did not transact business at the market price, even though he acknowledged its level in a letter (Cicero, 2 *Verr.* 3. 189). This observation, like most of the others, reports the prevailing local price in round numbers. Since the observation is general rather than the record of any transaction, it is likely to be only approximate. This casual quality of the data militates against finding any systematic relationship between prices. It introduces noise into any relationship of the prices being paid because of the unknown difference between the reported averages and actual prices. We analyze the effects of this noise on our test below.

The second price came from Polybius (Polyb. 34.8.7) in his discussion of conditions in Lusitania. As before, this is a general statement about the prevailing price. While it is good to have an average, the casual quality of the averaging process again adds noise into any comparison of prices in different places.

The third price comes from the Po Valley in Italy; it is another observation by Polybius (Polyb. 2.15.1). While this observation is closer to Rome than the first two prices, we have made an exception to our general rule. The Po valley was linked to Rome by rivers rather than sea. Diocletian's *Price Edict* fixed river transport prices at five times the level of sea transport, and we consider the cost of transport from the Po valley to have been five times as expensive as its actual distance if taken by sea. This evidence however dates from over a century later than any of the prices we observed. We assumed the ratio of sea and river transport costs remained constant over time—which others have confirmed—and we included the Po valley in our data by multiplying the distance from Rome by five.[8] Despite our small sample, we have enough data to test the usefulness of this assumption.

The fourth price comes from an official intervention in the local market. An inscription records that the wheat price was limited in a time of scarcity (*AEPigr* (1925), 126b). The normal price was eight or nine *asses* per *modius*; the acceptable limit price was one *denarius* per *modius*.[9] This inscription reveals several important aspects of the Mediterranean wheat market in addition to reporting the normal price. The need to damp down famine prices indicates that local markets were subject to local scarcities; they were not so well linked that wheat from elsewhere would be brought in instantly in response to

a local shortage. The apparent success of such interventions, in this case limiting the price to double its normal range, indicates that many famines were not severe.

For Egypt, we preserve the spirit of Rickman's data but improve on his data since Rathbone collected actual sale prices that are superior to the observations of average levels. We averaged seven Egyptian prices from the "famine" of 45-47 CE to get a price for Egypt. Rathbone argued that these prices were unusual, but the previous discussion suggests that they may not be far from average.[10] We of course cannot know how unusual these prices were, and any special conditions introduce noise into our data. The Egyptian prices also come from agricultural areas, not from a Mediterranean port. The purported famine would have raised the price, but using country prices would have depressed it compared to those at a port. These offsets introduce added uncertainty into the accuracy of this observation since there is no reason to expect them to be exact offsets. The average of Rathbone's seven prices was seven *drachmae* per *artaba*. These prices in Egyptian currency and units were converted to HS per *modius* by following Duncan-Jones and dividing by 4.5.[11]

Our final observation from distant Palestine, is taken from Tenney Frank's *Economic Survey*; it too is an average of a few actual transactions.[12] All of these prices were compared with roughly contemporaneous prices at Rome. Rickman argued that the price of wheat at Rome was between three and four HS per *modius* in the late Republic, rising to five to six HS in the early Empire. Duncan-Jones confirmed the general price level; Rathbone confirmed the inflation, at least for Egypt where the data are more abundant. The order of observations turns out to be almost chronological even though the order of exposition was by distance.

The prices and the differences between the prices at Rome and the local prices are shown in Table 1. The price differences are graphed against the distance from Rome in Figure 1. It is readily apparent that prices were lower outside of Rome than in Rome itself; all the price differences are all negative. This difference has been noted before.[13] It also looks as if the price differential between various locales and Rome became more negative as the locales were further from Rome. In other words, wheat prices everywhere were lower than in Rome and lowest at the farthest reaches of the Mediterranean, that is, at places farthest from Rome.

What could have produced such a pattern? We suggest that the whole Mediterranean basin was monetized in the sense that money provided a standard of value for wheat and presumably other goods as well. This standardization of the monetary unit, taking into account the different currencies in the East, promoted the development of a unified market for wheat, along the lines suggested by Schaps.[14]

If there had been a unified wheat market, how would it have worked? The main center of consumption would have been in Rome, where the largest number of potential consumers lived and the Roman government was located. In other words, Rome was where the largest excess supplies and demands for wheat would have come together and where the price of wheat consequently would have been set. The price would be lower in exporting regions in view of the transport costs to Rome. They would vary over time as supplies fluctuated due to harvests across the Roman world, storms affected the cost of transportation, and government actions altered the value of the currency. Normal variations in supplies and demands elsewhere in the empire would have affected the price in Rome, although most fluctuations would have been small relative to the total

production and the consumption at Rome. Most places outside of Rome would have had an excess supply of wheat, and the price would have been set in Rome where the excess supplies and the largest excess demand came together. When local places were isolated, there could be excess local demand as well as excess local supply, that is, local famines as well as local gluts.

Under these circumstances, wheat outside of Rome would be valued by what it was worth in Rome. Wheat at Palermo in Sicily, for example, normally would be worth less than wheat in Rome because it would have to be transported to Rome to be sold. The price of wheat in Sicily would be the price of wheat in Rome less the cost of getting wheat from Sicily to Rome. This would be true almost always, but there undoubtedly were circumstances when it was not. If storms prevented the shipment of grain to Rome, the Sicilian price might temporarily deviate from the level set by the price in Rome. If a harvest failure in Sicily created a local famine, the price of wheat in Sicily would rise above the level indicated by the Roman price until new wheat supplies could be brought in. In the absence of extreme events like these, a unified market would keep Sicilian prices near the Roman price less the transportation cost.

The market is an abstraction; it is misleading to say the market would determine Sicilian prices. More correctly, competition would determine Sicilian prices if there were a unified market. If the Sicilian price of wheat rose above the Roman level minus transportation costs, merchants would not buy wheat in Sicily to sell in Rome. The amount of wheat demanded in Sicily would fall, and the price consequently would fall as well. If the Sicilian price of wheat fell below the Roman level minus transportation costs, merchants would increase the amount of wheat they would try to buy in Sicily, for they

could make an unusually high profit by taking it to Rome and selling it there. Merchants would bid against each other, raising the Sicilian price.

Wheat at Lusitania in Spain would be worth less than wheat at Palermo because it was further from Rome. The cost of transporting wheat from Spain to Rome was larger than the cost of bringing it from Sicily, and the price of wheat in Spain correspondingly would be lower. The reasoning is exactly like that for Sicily, only the transport cost is different. But while each price is compared to that in Rome, the price in Spain would be lower relative to the price in Sicily if there were a unified market. In fact, wheat around the Mediterranean would be worth less than the price at Rome, with the amount less depending on the distance from Rome. We do not know the transport cost in any detail, but we are reasonably sure that it rose with distance. If there was a unified wheat market, therefore, the price of wheat would have decreased as one moved farther and farther from Rome.

All this presumes monetization throughout the Mediterranean. The comparisons assume that there were monetary units in which prices could be compared. In fact, most of the observations were in the same monetary units, and the others were translated to these units by a standard exchange rate. The anticipation of profits from trade presupposes that the value of the wheat could be compared with the value of other goods and services and traded for them. Without monetization, there can be only the simplest kind of trade because the opportunities are very hard to evaluate.

This hypothetical account of trade sounds impossibly modern. But if it is not an accurate picture of the Roman world, we need to think of the relevant alternative. Phrased differently, what is the alternative to this view? If there were not a unified

currency or market, if there were only independent local currencies and markets, then we would not expect to find any relationship between local and Roman prices. Prices in local prices and markets would be determined by local conditions. The prices might move together at some times, if storms around the Mediterranean caused simultaneous harvest failures everywhere or currency debasements caused prices to rise everywhere, but the prices would not in general be related one to another. Any single identity of prices could be a coincidence, and it is impossible to say if similar miners' wages in Egypt and Dacia were the result of coincidence, government regulation, or a market for miners.[15] If we could find several wheat prices in different places, however, we could test whether the pattern we find is due to coincidence or an underlying market process.

The question is not whether one or the other of these ideal types was observed, either that there was a single monetary area and an efficient market or that there were no factors unifying separate local moneys and markets. It is rather whether the historical experience lies closer to one end of a continuum than the other. There must have been at least occasional local shortages and famines. The question then is whether the normal state of affairs was one of interconnected currencies and markets, so that prices in different places typically were related, or one of separated and independent currencies and markets. In the latter case, we should not observe any systematic relationship between the location and the price of grain. If the economies in these places had not been monetized, of course, we would not have observed any prices at all.

A Test of Market Integration

It may appear as if the picture in Figure 1 could only be suggestive of such a story. It seems like a tiny bit of evidence on which to hang such a grand story of universal monetization and market integration. There is however a statistical technique that can be used to evaluate how likely it is that a picture like Figure 1 could arise by chance. In other words, we can test the probability that the separate areas of the early Roman Empire were isolated and out of economic connection with Rome. Their prices would have been determined by local conditions, including perhaps the degree of monetization. There would have been no connection between the distance to Rome and the level of local prices.

This statistical technique is known as regression analysis. In this type of analysis we can evaluate the likelihood that there is a relation between the local price and the distance from Rome. We start by trying to draw a line that relates the price difference between the local price and the Roman price to the distance from Rome. We then adjust the line to make it the best description of the data in the sense that it minimizes the squared distance of the individual observations from the line. (We use the square of the distance to minimize the distance from points both above and below the line and to simplify the mathematics.) This process is known as regression analysis or the method of least squares, and the resulting "least-squares" line is the regression line. It is shown in Figure 2.

One of the values of regression analysis is that it generates tests of the hypotheses being tested. We can ask if an apparent relationship between the price discount and the distance from Rome is illusory, a result of observing only a few prices, rather than the result of a systematic process. In order to draw this line, we assumed that there was a

relationship between the distance from Rome and the price discount. Regression analysis provides a test whether there is such an association in the data. This test tells us how unlikely it is for us to find a line like the one shown in Figure 2 by chance. Assume that the prices we gathered from Rickman were randomly drawn from an underlying distribution of price observations. In another world, different prices would have survived from this same distribution. Taking account of the random quality of the observations we actually have, how unlikely is it for us to find the line in Figure 2 by chance?

Regression analysis acknowledges that the slope of the line in Figure 2 is not known with certainty. It is the best line that can be drawn with the data at hand, but it is subject to errors deriving from the incomplete sampling of the underlying distribution. In the jargon of regression analysis, the slope of the line has a standard error. If all the points in Figure 1 and 2 lay in a straight line, then the slope of the regression line would be clear, and the standard error of the slope would be close to zero. If the points are spread out as they are in the figures here, then the line is not known as clearly, and there is a chance that the line has no slope at all, that is, that there is no relationship between the distance from Rome and the price difference.

The test is to compare the size of the slope, the coefficient in the regression, with the size of its standard error. If the coefficient is large relative to the standard error, then it is unlikely that the line was a random finding without support in the price data. On the other hand, if the coefficient is small relative to its standard error, then it is possible that even though the regression line has a slope, there is no underlying relationship between the price and distance. Statisticians call this ratio a t-statistic, and they have calculated tables that can translate t-statistics into probabilities that the line is observed by chance.

The tables take account of degrees of freedom, that is, the number of observations minus the number of coefficients. It takes two variables to define a line, its slope and its position (height in the figures). With six observations and two variables, there are four degrees of freedom. Omitting the observation with river transport reduces the number of observations by one and the degrees of freedom to three. The t-statistic has to be larger with such few degrees of freedom than with more degrees of freedom to show that a given regression line is unlikely to be the result of chance.

One might think that the data—composed of only a few, badly observed values—are too poor for statistical analysis. Nothing could be further from the truth. Statistics are the best way of distinguishing signal from noise; they are particularly useful when there is a lot of noise in the system. They give us a precise sense of how unlikely it is that any putative pattern we think we observe would have been generated by random processes, that is, how unlikely it is that what looks like a pattern actually is noise. The value of statistics is that we can test a formal hypothesis, namely that wheat prices around the Mediterranean Sea were related in a simple way to those at Rome. We also can derive an explicit probability that this hypothesis is true, given the observations we have.

In particular, errors in variables are a common problem in doing regressions. We often hypothesize a relationship between two variables—like the price in Rome and the price in Egypt—but cannot observe one or the other of them precisely. We then use a proxy such as the occasional price that happens to be mentioned in a surviving document, as we have done here for most of our prices. The errors introduced by such a procedure have been studied, and their effects are well known. The extra uncertainty introduced by using imperfect proxies reduces the explanatory power of regressions and tends to result

in coefficients and t-statistics that are near zero; the addition of noise through imperfect observations makes the results look more like noise. The well-known scarcity of Roman prices makes it very hard to find a pattern in them. When a pattern is found, however, it indicates that there is a strong relationship between the prices.

The price differentials are graphed against the distance to Rome in Figure 1. The results are quite striking; prices were lower in places further from Rome, and the price differentials appear almost proportional to the distance from Rome. These prices come from all over the Mediterranean and from various times in the late Republic and early Empire. If there were not a unified monetary system or if there were not a unified grain market, there would be no reason to expect a pattern in these prices. Even if there was a unified market, our inability to find more prices or more accurate transportation costs might have obscured any true relationship among the prices. Yet Figure 1 reveals a clear picture.

While the graph is clear, a statistical test is needed to tell if the observed pattern could be the result of chance. Accordingly we ran regressions of the price differential on the distance from Rome, with the results shown in Figure 2 and Table 2. There are four separate regressions in the table. Since the transportation from the Po valley was by river rather than sea, we were not sure that the correction for the relative cost of transport was accurate, and we tried the regressions both with and without the Po valley data point. In addition, we expressed the distance in logarithms to measure the proportional change in it to allow the relationship between price and distance to be non-linear. The dependent variable is the premium of the Roman price over the local price instead of the discount of the local price from the Roman price.

Each row of Table 2 contains the result of a separate regression. The first two columns identify the regression by whether we used the distance or its log and whether we included the Po valley. The next two columns give the coefficients resulting from the regression with the relevant t-statistic below it in parentheses.[16] There are two columns because a straight line is defined by two parameters, a constant and a slope. The first column gives the constant. It measures the difference between the price in Rome and elsewhere that was not related to distance. The second column gives the slope of the line in Figure 2. It measures the speed at which the discount from the price in Rome grew as distance from Rome increased.

How can we be sure that the price discount increased with distance? The t-statistics below the coefficients indicate that it is highly unlikely that there is no relationship between the local price and the distance from Rome. They are all larger than three. A t-statistic above three indicates that there is less than one chance in twenty that the observed relationship between distance and price differentials was due to chance.[17] In other words, we confirm with very high probability that there was a unified wheat market that extended from one end to the other of the Mediterranean Sea, that transport costs were roughly proportional to distance, and that the effects of distance were larger than the idiosyncratic influences of particular markets, currencies and places. This level of confidence is taken as conclusive in most economic and medical tests done today.

The R^2 shown in the final column measures the share of the variance of the price differentials that is explained by these simple regressions. Using the price differentials themselves, the regression explains almost four-fifths of the variation. Using logarithms of distance, the regressions explain even more. This result confirms the impression in

Figure 2 that distance from Rome is a powerful explanatory factor in determining wheat prices around the Roman Mediterranean.

The constant terms in these regressions were negative in the regressions for price discounts (and positive in the regressions for the logarithms). They were not estimated as precisely as the relationship between distance and the price differentials, so we cannot be as sure that they are not the result of chance (as indicated by smaller t-statistics). The constant terms suggest that there were some costs to bring wheat to Rome that were not proportional to distance, albeit smaller and less well observed. These other costs could have been physical—the costs of transshipping wheat to and from sea-going ships—or administrative—like port charges or taxes. Their presence does not detract from the effect of distance or the evidence in favor of a unified wheat market.

It does not make a big difference whether the Po valley is included or not. Without this observation, the standard error of the slope coefficient is slightly larger, making the t-statistic slightly smaller. The required t-statistic to show the probability that the slope is not zero also rises due to the fewer degrees of freedom. Nonetheless, the probability that there was no relationship between price and distance from Rome is still less than one in twenty. The slope of the line and the percentage of the price variation that is explained by distance do not change. As can be seen in Figure 2, the observation for the Po valley lies close to the regression line; removing it does not change the line.

This graph and these regressions provide powerful evidence for the existence of extensive monetization and unified wheat markets in the later Roman Republic and the early Roman Empire. Other authors have inferred the existence of such markets from isolated observations, but we have demonstrated the existence of a relationship between

prices in far-flung places that almost certainly is not the result of chance. Such a relationship could only exist where the standard of value, money, was used throughout the Mediterranean.

Possible Objections

We discuss in this section possible objections that can be raised to this test and our conclusion. The first objection is that prices were low outside Rome because coined money was scarce, not because transport to Rome was costly. This alternative cannot explain the prices in Table 1. Coins may have been scarce in Lusitania at the time of Polybius, but coins were abundant in the eastern Mediterranean where the monetized Greek economy preceded the Roman one. Wheat prices there were lower than in Lusitania, as can be seen from the figures. Distance from Rome is a much better predictor of prices than coin scarcity.

A second objection is that the prices are unrepresentative because they are notional, biased because the observers had political motives, or unrepresentative due to price fluctuations. We acknowledge that such errors in the price observations may have been present, although Polybius was a very careful historian, not liable to falsify his evidence to make a rhetorical point. As noted already, such errors in recording the "true" prices introduce noise into the relationship between the price differential and distance from Rome. If there was a great deal of this distortion, any existing relationship might be obscured. Since we find such a relation, it means that the relationship between distance and price was a strong one, visible even through the noise introduced by casual or distorted price observations. More formally, we can think of the observed prices being

determined by the true prevailing prices, which we observe with an error due to our approximation. Then the dependent variable we used in the regression is the true distance plus an error. That error would add onto the error of the regression and result in a lower t-statistic and R^2. Given that they both are large, we conclude that this rough assumption in fact is quite good, that the observed prices appear to represent prevailing prices in a reasonable fashion.

Another, related objection is that prices fluctuated during the year and observations may have come from different seasons. Again, this source of noise strengthens our results because the seasonal price variation introduces another source of noise into the hypothesized relationship. We suspect that the casual nature of the price observations has helped us here. Travelers were told of the prevailing price, not sometimes the extreme price that obtains just before the harvest comes in and sometimes the low price following the harvest. The result appears to be a consistent set of prices. Phrased differently, we regard the few prices that have survived for two millennia as quite random, but it is perverse to insist that any pattern we find has to be spurious. There does not seem to be a reason to throw out evidence from the ancient world on the grounds that it must be random.

Yet another objection to the use of these prices is that the argument is circular: we assume the data are sound because they support the hypothesis, but the test of the hypothesis requires the data to be sound. Not at all. We assume that the prices we observe are drawn from a distribution of prices in the early Roman Empire (and late Republic). We do not assume they are accurate or come from a particular kind of investigation or a particular time of year (as in the previous paragraph). In fact, we only

assume that they are prices. Given that we are sampling from the population of wheat prices, the t-statistic tells us whether there is a relationship between price and distance. There is no more circularity here than in any statistical test of a hypothesis.

Another objection is that the sample is tiny, only six price pairs. This small sample is unfortunate, but no barrier to the test of our hypothesis. As we said above, the standard errors and t-statistics are corrected for degrees of freedom. Having few observations makes it easier to reject hypotheses, but it does not affect the validity of the test. We would of course like to have many more prices, but there are not more to be found at this time. Perhaps our analysis of these few prices will stimulate other historians to find more price pairs and to provide more evidence for or against our hypothesis.

A little thought experiment might be useful here. Imagine that we discover a steady stream of new wheat prices from various locations. If they all lie near the regression line in Figure 2, they provide more evidence for our hypothesis. Prices that do not lie near the regression line indicate that the locations in question were isolated from the general Mediterranean wheat market or the main currency area at the times of the price observations. If we only find a few such observations, that would enrich the historical record without vitiating the hypothesis of a generally unified market. If we found a lot of such prices, that would suggest that conditions where markets were isolated were more prevalent than times when they were integrated. The Roman world in that case would be monetized, but not composed of a unified monetary system.

We remarked earlier that imperial officials often intervened in the market for wheat. If the government was administering prices, then the prices might not be the result of market forces at all. To check this possibility, we searched for price

interventions in Rome. The government repeatedly attempted to avoid the hardships of price spikes when supplies ran short. In 74 BCE, the government sold grain cheaply to offset the loss of wheat in Sicilian floods. In 57 BCE Pompey negotiated extra purchases himself, sailing from province to province in search of wheat. In 24 BCE Augustus gave 400 HS apiece to 250,000 people, allowing them to purchase wheat that was temporarily expensive. In 19 CE Tiberius placed a price ceiling on grain and offered to compensate merchants two HS per *modius*, suggesting that the price before his intervention was at least two HS above the price he thought people could bear. In 64 CE Nero set another price ceiling for wheat, this time at three HS per *modius*.[18]

Government interventions like these are summarized in Table 3. It is clear that the government intervened in the wheat market from time to time, particularly under Augustus. It also is clear, even from what must be a partial list, that these interventions were intermittent. If we assume that these interventions are only half of the actual actions, the others being unrecorded in our sources, the years in which there were interventions were still clearly a minority. The market for wheat was allowed to work on its own in most years. In addition, if traders expected the government to interfere when famine loomed, they might have been discouraged from trying to corner the market in adversity. Government intervention therefore may have damped speculation and made the underlying pattern of prices easier to see.

The largest government activity in the wheat market was the *annona*. The government gave 60 *modii* per year to each male head of a household. The number of households receiving this largess is unclear, but it is generally thought to be between 200,000 and 250,000 during the reign of Augustus.[19] If the population of Rome was

around one million people, the *annona* used between half and a quarter of the wheat imported into Rome. More than half of the wheat imported to Rome at the time of Augustus therefore was imported privately. Sirks argued that the share of grain imported into Rome for the *annona* was even smaller, only around 15 percent, making the private share correspondingly larger.[20]

The government also obtained the wheat for the *annona* privately. They let contracts to *societates* to provide wheat, and they offered inducements for private merchants to participate in this process. Claudius rewarded private merchants who used their own ships, carrying at least 10,000 *modii*, to import grain to Rome for the *annona* for five years. If the merchant was a citizen, he would be exempt from the *lex Papia Poppaea*, which penalized the childless. If the merchant was a woman, she could make a will without the intervention of a male tutor. And if the merchant was not a citizen, he would be granted citizenship. Hadrian extended these rewards by exempting any merchant devoting the greater part of his resources to the *annona* from compulsory services imposed by municipal authorities.[21]

The wheat market in Rome consequently was a mixture of public and private activity. There was enough private activity to provide work for many merchants and shippers who would gather wheat from the far corners of the Mediterranean. But the public presence means that the price of wheat in Rome may have been distorted by the *annona*. We have discussed price variation already, and government actions probably stabilized prices more than they destabilized them. The presence of so much free wheat in Rome however may have decreased the price of wheat in that city at all times. If this price was received by importers, then the graphs and regressions record the proper

relation between Roman and provincial prices. If the price we observe was different from the price paid to importers, this would change the constant in the regression and move the line in Figure 2 up or down. It would not affect the relationship in Table 2 or the slope of the line in Figure 2 (unless of course the officials of the *annona* paid different prices for wheat from different places—for which there is no evidence at all).

Coming back to monetary conditions, there is evidence of inflation in the early Roman Empire. The pay of soldiers was increased in infrequent large jumps, and wheat prices in Egypt rose.[22] We used the price difference between Roman and provincial prices in order to avoid problems of inflation. As shown in Table 1, we take account of inflation in Rome. While the incomplete evidence on inflation suggests there were a few jumps in prices, it is more likely that they were drifting upward more or less steadily. In any case, the use of a price difference insulates our test from an inflationary bias.

Turning to the other variable, distance, we acknowledge that a straight-line distance is only a rough approximation to the actual distance traveled by wheat on its way to Rome. This defect of the data however is an advantage for our test; it biases our test toward rejecting our hypothesis. The approximate nature of the distance estimate introduces another kind of error in the variables. Since this is our independent variable, the effect is slightly different from the effect of an error in observing the price. Any error in observing distance has the effect of reducing the size of the resulting coefficient. Since is large, as can be seen in Figure 2, straight-line distances appear to give a good representation of the comparative distance from Rome despite the waywardness of any specific voyage to the capital city.

Finally, this is a very simple model of Roman monetization and trade. We have argued that there was a single monetary system and a single wheat market across the whole Mediterranean. We tested this hypothesis with a simple regression and few degrees of freedom. Why should any ancient historian believe such a simple model and test? We argue that the purpose of a model is to provide an overall view of money and trade in Rome. It does not explain every detail; instead it provides an overview that can help our thinking. There are only a few observations because that is all we have. If we studied more recent times, we would have more data, but we do the best we can with ancient history. As we said above, we hope that our exploration will stimulate ancient historians to search for added price observations. We will be as interested as any reader to see if this simple model survives a test with more data.

Conclusion

We have argued here that the early Roman Empire was thoroughly monetized. We do not argue that people everywhere had adequate supplies of Roman coins, but rather that people throughout the empire used a single monetary standard to value their activities. This single monetary standard was based on *sestertii* in the western empire and on *drachmae* in the eastern empire, with a fixed exchange rate between them. The result was to create a single currency area like the euro zone today. Whether or not all regions had adequate supplies of coin, the survival of prices from all corners of the empire indicate that the Roman economy was thoroughly monetized.

We argued also that this monetization set the conditions for market integration by reducing the transactions cost of trading across large distances. This allowed a single

market for wheat to emerge, whose existence we could verify from surviving prices. The enormous size of Rome also encouraged the growth of trade, since all the residents of the capital needed to eat. Food must have traveled around the Mediterranean for eons before the Roman conquest.[23] The quantities shipped were too small, however, to make a unified market. Only when the Romans imposed a political settlement on the area and created a unified monetary system could trade expand enough to unify prices across the Mediterranean.

Table 1: Distance and Prices for Grain					
Region	**Distance (km) from Rome**	**Rome Price (HS)**	**Province Price (HS)**	**Distance-from-Rome "Discount" (HS)**	**Year**
Sicily (*Sicilia* province)	427	4.00 HS [a]	2.00-3.00 HS [c]	-1.50	77 BCE
Spain (*Lusitania* province)	1363	3.00-4.00 HS [a]	1 HS [d]	-2.50	150 BCE
Po valley (*Italia* province), by river	1510	3.00-4.00 HS [a]	0.5 HS [b]	-3.00	150 BCE
Asia Minor (city of Pisidian Antioch)	1724	5.00-6.00 HS [a]	2.00-2.25 HS [e]	-3.13	80s CE
Egypt (Region of the Fayum)	1953	5.00-6.00 HS [a]	4 HS [f]	-4.00	20 BC – 56 CE
Palestine	2298	5.00-6.00 HS [a]	2.00-2.50 HS [g]	-3.25	15 CE
Sources: [a] Rickman, *Corn Supply*, 153-4 [b] Polyb. 2. 15 [c] Cicero, 2 *Verr.* 3. 189. [d] Polyb. 34. 8. 7. [e] *Æpigr.* (1925), 126b. [f] P. Mich. II 1271.1.8-38 [g] Frank, ESAR iv, 181 and 183.					

Table 2: Distance Discount Regression Results				
	N	α	B	R^2
Distance Discount	6	-1.10 (2.2)	-0.001 (3.9)	0.79
Distance Discount (no Po valley)	5	-1.16 (2.0)	-0.001 (3.4)	0.79
Log Distance Discount	6	-6.14 (2.8)	-1.25 (4.1)	0.81
Log Distance Discount (no Po valley)	5	-6.04 (2.7)	-1.25 (4.1)	0.85
Source: Table 1. Absolute value of t-statistics below coefficients.				

Table 3: Selected Government Interventions in the Grain Market		
Date	**Intervention Type**	**Source**
138 BC	Rising prices lead tribunes to seek extra grain supplies.	Obsequens 22 (142).
100 BC	Feared shortage leads Senate to seek extra grain stock.	M. H. Crawford, *Roman Republican Coinage: Volume 2* (Cambridge: CUP, 1974), 74 and 616.
75 BC	1 ½ *modii* distributed free per man given shortage.	Cicero, *Planc.* 64. Cicero, *2 Verr*, 3.215.
74 BC	Aedile distributes grain at 1 AS per modius.	Pliny, *Hist nat.* 18.16.
66 BC	Pompey tours Sicily, Africa, and Sardinia to secure extra grain in his capacity as grain commissioner.	Cicero, *Imp. Pomp.*, 34.
62 BC	Cato's Lex Porcia raises grain outlay to 30 million HS or adds that much to the budget.	Plutarch, *Cato Min.* 26.1
58-56 BC	Cicero appoints Pompey for grain supply, price falls.	Cicero, *Dom.* 10-12, 14-18; *Att.* 4.1; Cassius Dio, 39.9.3, 24.1; Cicero, *Q. fr.* 2.5; *Har. resp.* 31; Plutarch, *Pomp*, 49.4-50.2
49 BC	Caesar distributes grain to starving Romans during the civil war (Garnsey, 202).	Cicero, *Att.* 7.9.2, 4; 9.9.4; *Fam.* 14.7.3; Appian, *Bell. civ.* 2.48; Cassius Dio 41.16.1
29 BC	Augustus gives 400 HS to 250,000 people.	*Res gest.*, 15.
24 BC	Augustus gives 400 HS to 250,000 people.	*Res gest.*, 15.
23 BC	Augustus give money and "12 rations" to 250,000 people. Tiberius also helps, and Suetonius says he "skillfully regulated the difficulties of the grain supply and relieved the scarcity of grain at Ostia and in the city."	*Res gest.*, 15. Suetonius, *Tib.* 8.
22 BC	Augustus gives grain to many.	*Res gest.*, 5.
18 BC	Augustus gives grain to at least 100,000.	*Res gest.*, 18.
11 BC	Augustus gives 400 HS to 250,000 people.	*Res gest.*, 15.
5 BC	Augustus gives 240 HS to 320,000 people.	*Res gest.*, 15.
2 BC	Augustus gives 240 HS to 200,000 people.	*Res gest.*, 15.
6 AD	Augustus gives grain to many. Also expels some foreigners from the city to alleviate the crisis. (Garnsey, 221)	Cassius Dio 55.22.3.
19 AD	Tiberius imposes price ceiling, gives dealers + 2 HS	Tacitus, *Ann.*, 2.87.
51 AD	Claudius encourages merchants to sail in winter. (Garnsey, 223)	Tacitus, *Ann.*, 12.43.
64 AD	Nero fixes price at 3 HS, *annona* suspended	Tacitus, *Ann.*, 15.39.
189 AD	Commodus engages in price-fixing.	Herodian 1.12.2-4; Cassius Dio 72.13.2.

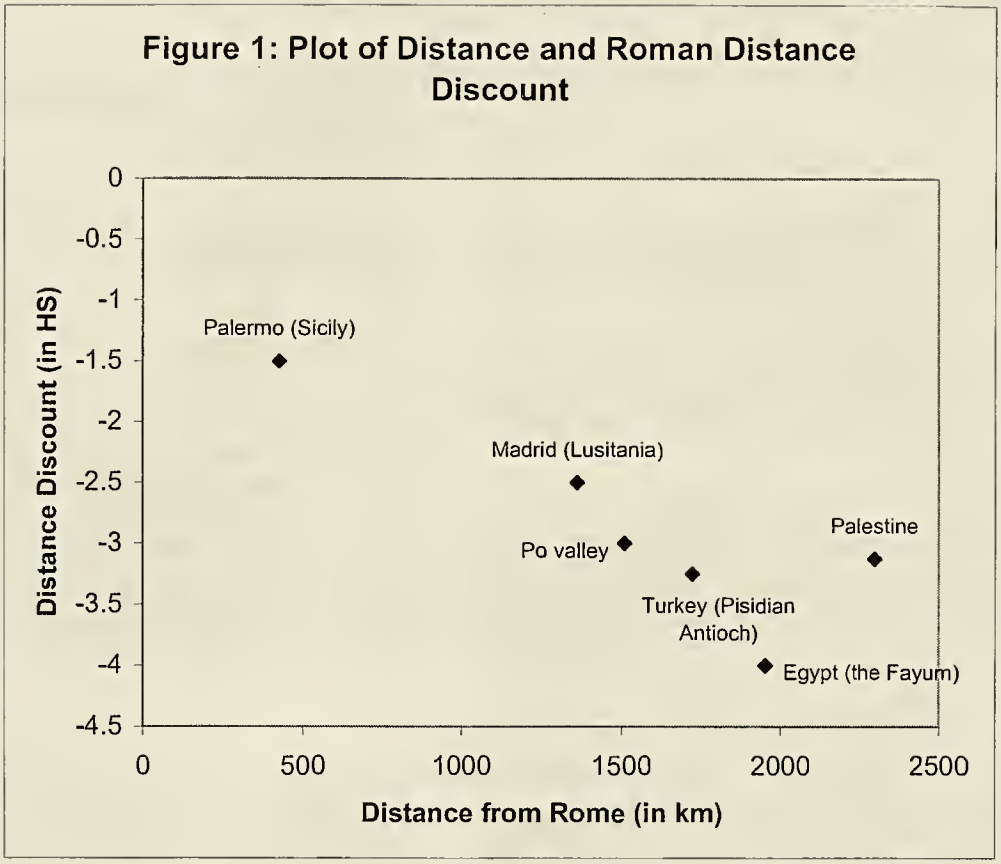
Figure 1: Plot of Distance and Roman Distance Discount
Distance Discount (in HS)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
Palermo (Sicily)
Madrid (Lusitania)
Po valley
Palestine
Turkey (Pisidian Antioch)
Egypt (the Fayum)
0
500
1000
1500
2000
2500
Distance from Rome (in km)

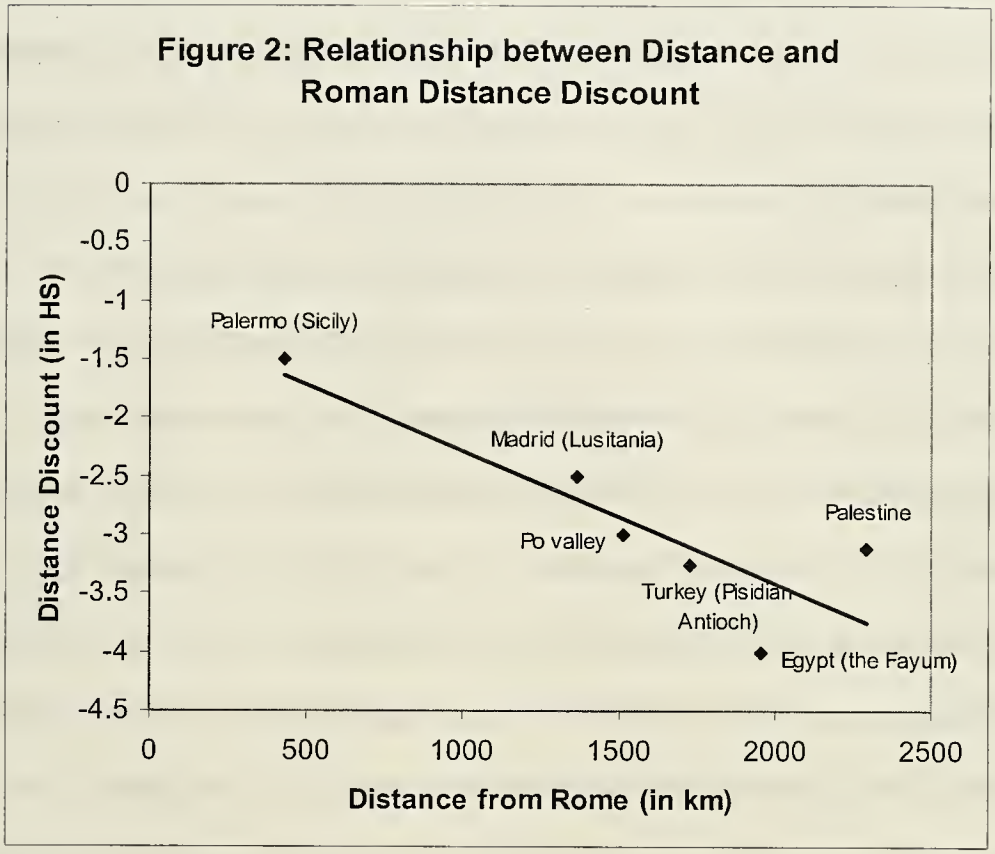
Figure 2: Relationship between Distance and Roman Distance Discount
Distance Discount (in HS)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
Palermo (Sicily)
Madrid (Lusitania)
Palestine
Po valley
Turkey (Pisidian Antioch)
Egypt (the Fayum)
0
500
1000
1500
2000
2500
Distance from Rome (in km)

Endnotes

[1] Sometimes a third function, a store of value, is added, but this is not relevant here. Kevin Greene, *The Archaeology of the Roman Economy* (Berkeley, CA: University of California Press, 1986), pp. 50-51. This assertion can be found in almost any elementary economics text.

[2] Keith Hopkins, "Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400)," *Journal of Roman Studies* 70 (1980), 101-125; Richard Duncan-Jones, "The Denarii of Septimus Severus and the Mobility of Roman Coin," *Numismatic Chronicle*, 161 (2001), 75-89.

[3] Richard Duncan-Jones, *The Economy of the Roman Empire: Quantitative Studies* Second Edition (Cambridge: Cambridge University Press, 1982); Hans-Joachim Drexhage, *Preise, Mieten/Pachten, Kosten und Löhne im römischen Ägypten bis zum Regierungsantritt Diokletians* (St. Katharinen: Scripta Mercaturae, 1991); Dominic Rathbone, "Prices and Price Formation in Roman Egypt," *Economie antique. Prix et formation des prix dans les economies antiques* (Saint-Bertrand-de-Comminges: Musee archeologique departmental, 1997), 183-244.

[4] David M. Schaps, *The Invention of Coinage and the Monetization of Ancient Greece* (Ann Arbor, MI: University of Michigan Press, 2004).

[5] Rathbone, "Prices," pp. 191-92.

[6] Geoffrey Rickman, *The Corn Supply of Ancient Rome* (Oxford: Oxford University Press, 1980), pp. 143-55.

[7] Duncan-Jones, *The Economy of the Roman Empire.*

[8] Kevin Greene, *The Archaeology of the Roman Empire* (Berkeley: University of California Press, 1986), p. 40.

[9] William Mitchell Ramsay, "Studies in the 'Roman Province Galatia' VI—Some Inscriptions of Colonial Caesarea Antiochea," *Journal of Roman Studies* 14 (1924), pp. 172-205, at 180.

[10] Rathbone, "Prices," 193.

[11] Duncan-Jones, *Economy of the Roman Empire*, 372. For information about transport within Egypt, although not its cost, see Adam Bülow-Jacobsen, "The Traffic on the Road and the Provisioning of the Station," in *La route de Myos Hormos*, edited by Hélène Cuvigny (Le Caire: Institute française d'archéology orientale, 2003), Vol 2, pp. 399-426.

[12] Tenney Frank, *An Economic Survey of Ancient Rome* (Paterson, NJ: Pageant Books, 1959), Vol. 4 (Heichelheim), 181-83.

[13] Garnsey, for example, observed casually and without apparent need for documentation that oil and wine cost more in Rome than elsewhere. Peter Garnsey, *Cities, Peasants and Food in Classical Antiquity* (Cambridge: Cambridge University Press, 1998), 241.

[14] Schaps, *Invention of Coinage*.

[15] Hélène Cuvigny, "The Amount of Wages Paid to the Quarry-Workers at Mons Claudianus," *Journal of Roman Studies*, 86 (1996), 139-45.

[16] The sizes of the coefficients rise when we use logarithms since the logarithm of a number typically is smaller than the number. T-statistics are the same sign as the coefficient, but we have reversed the signs of the t-statistics in Table 2 to make the description more intuitive.

[17] In the more precise language normally used for regressions, the probability of observing the coefficients in the table if there were no relationship between the price of wheat and the distance from Rome is less than five percent in three out of four

regressions and close to that probability in the fourth. The five percent value of the t-statistic for four degrees of freedom (six observations) is 2.8; for three degrees of freedom (five observations), 3.2. Higher t-statistics indicate lower probabilities that the observed relationship is the result of chance.

[18] Peter Garnsey, *Famine and Food Supply in the Graeco-Roman World* (Cambridge: Cambridge University Press, 1988) 195-222; Rickman, *Corn Supply*, 150-54.

[19] Catherine Virlouvet, *Tessera frumentaria: les procedures de distribution du blé public à la fin de la République et au dèbut de l'Empire* (Rome: École Française de Rome, 1995); Garnsey, *Cities, Peasants and Food*, 236.

[20] Boudewijn Sirks, *Food for Rome* (Amsterdam: Gieben, 1991), 21. Jongman argues that the *annona* provided bare subsistence for half the free population of Rome, that is, less than half of total wheat imports. Willem M. Jongman, "Consumption in the early Roman Empire," in Richard P. Saller, Ian Morris and Walter Scheidel (eds.), *The Cambridge Economic History of the Greco-Roman World* (Cambridge: Cambridge University Press, 2006).

[21] E. Badian, *Publicans and Sinners* (Oxford: Basil Blackwell, 1972); Garnsey, *Famine and Food Supply*, 234; Sirks, *Food for Rome*, 63.

[22] George R. Watson, *The Roman Soldier* (Itahaca, NY: Cornell University Press, 1969), 89-92; Rathbone, "Prices."

[23] Peter Temin, "Mediterranean Trade in Biblical Times," in *Eli F. Heckscher: A Celebratory Symposium*, edited by Ronald Findlay and Mats Lindahl (Cambridge: MIT Press, forthcoming).

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